0025

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September 28, 1999

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Copy sent (all)

RE: Letter of transmittal for 1999 Vegetation Monitoring Survey by Bamberg Associates for- J.B. King reclaimed minesite, ACT/015/002, Folder #2, Emery County, Utah

Dear Pamela:

Please find attached two (2) copies of the Bamberg Associates document entitled: ***August 1999 – Plant Surveys at the Reclaimed J.B. King Mine, Emery County, Utah- Monitoring During 1999 for Vegetation Composition and Compliance with Reclamation Standards/Final Bond Release.***

If you have any questions, please let me know at your earliest convenience.

Sincerely,

E.M. (Buzz) Gerick
Vice President of Operations

Cc: J.B. King file

PLANT SURVEYS AT THE RECLAIMED

J.B. KING MINE, EMERY COUNTY, UTAH

MONITORING DURING 1999

FOR VEGETATION COMPOSITION AND COMPLIANCE WITH

RECLAMATION STANDARDS - FINAL BOND RELEASE

Submitted to
WESTERN STATES MINERALS CORPORATION
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August 1999

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1.0 INTRODUCTION

Bamberg Associates conducted a monitoring survey of the plant cover and shrub density on the reclaimed portion of the J. B. King Mine site and its associated reference area for Western State Minerals. Our survey will help establish if the site meets the vegetative criteria required by the Utah Division of Oil, Gas, and Mining (The Division) for Phase II and III bond elease. For the first ten years of the bonding period, monitoring has been conducted on the site every two years as required by the Division (Boucek 1987, Bamberg and Bamberg 1989, Bamberg and Hanne 1991, 1992a, 1993a, 1994). The first year for monitoring was 1998 during an extended bond period after additional reclamation in December 1994 (Hansen, Allen, & Luce, 1994). This 1999 survey was for the second of 2 consecutive years of required monitoring for bond release.

The J.B. King Coal Mine is located approximately 10 linear miles south of Emery, Utah in Emery County; Range 6 East, Township 23 South, Section 32, SLBM. Western States Minerals Company operated this mine and requested this monitoring survey to comply with a Phase II and III Bond Release. The mine was initially reclaimed in 1984-5 based on previous studies (Native Plants, 1983) for plant species seeded and methods. A portion of the mine was reclaimed in 1994 using newer methods (Bamberg and Hanne, 1993b, Hansen, Allen, & Luce 1994).

We monitored vegetative cover by species, plant diversity, and woody plant densities, although only vegetative cover was required. Our monitoring methods followed the procedures for vegetation cover and shrub density established in the past surveys. These surveys are detailed in the baseline inventory reports (Bamberg and Bamberg l989, Bamberg and Hanne 1991, 1992, and 1993). The present survey was performed on July 26 and 27, l999. Susan White of the Division of Oil, Gas, and Mining was present during the monitoring, and assisted in plant identification, cover estimates, and shrub counts in sample quadrats on both the mine site and reference area.

The results of our monitoring surveys showed that the reclaimed mine site has successful revegetation. Total desirable plant cover on the mine site averaged 18.4% in 1998 and 18.7% in 1999. The established reference area for this mine averaged 13.1% and 19.8% plant cover in 1998 and 1999 respectively. Sample adequacy for both the site and the reference area were determined and met in 1998. Sample adequacy was not met in 1999 for the mine site. Although not required by The Division, we measured shrub density and calculated 2875 and 4633 shrubs per acre on the site and 8400 and 4800 shrubs per acre on the reference area in 1998 and 1999

respectively.

Since the site meets the criteria for level of plant cover based on the reference site, we recommend that the J.B. King Mine be released from the bond based on vegetative cover.

2.0 METHODS

We established a grid system and randomly selected plots monitored by a quadrat sampling method. The grid system and size of the quadrat were adjusted for the vegetative conditions of the reclaimed site and the reference area. We used the same methods on the J.B. King site and the reference area. Each quadrat was analyzed for ground cover and shrub density. Sample adequacy was calculated for both the site and the reference area. We concluded our monitoring with a visual inspection of the site for overall plant condition and vigor, degree of erosion, and level of disturbance.

The entire reclaimed site was treated as one unit including the refuse pile area contoured and seeded in 1994. The Division test plots reclaimed in 1994 on the flat area of the refuse pile were also included in the surveys. According to Susan White, a small area of less than one quarter acre was rough graded and reseeded in the spring of 1999. This area is too small to effect the bond release timing but is almost totally devoid of vegetation because of the short time since seeding. A couple of the monitoring plots fell within this area and were included in the cover and density determinations.

2.1 General Methodology

We used the same methods for ground cover and shrub density monitoring as during the previous surveys according to UMC 784.13 of the approved permit. These methods consisted of locating randomly located sampling quadrats and recording percent cover of plants by species, litter, rock, and bare ground. We also recorded percent ground covered by standing dead plant material as requested by Susan White of the Division. We included in our survey a shrub density count of the mine site and reference area and a visual inspection of the mine site.

We established a grid system on both the reclaimed section of the mine site and the reference area during the 1998 survey. This system is similar to the grids established in 1989, 1991, 1993, and 1998 sampling grids. The grids were in the form of a cross using two staked lines at ninety degrees to each other. The distance between nodes was 30 meters (98.4 feet) on the mine site

and 15 meters (49.2 feet) on the smaller, more uniform reference area. Each node of the grids was numbered. The nodes used as sampling points were determined using a random number generator.

The location of each sample quadrat from each sample node was determined by tossing a pen over our shoulder. We always laid out the quadrats to the southeast. Quadrats measured 4 m^2 (43.03 f^2) on the mine site and 1 m^2 (10.76 f^2) on the reference area. We had determined these optimal quadrat sizes for the site and reference area during previous surveys using a nested species area curve (Bamberg and Hanne, 1992). Vegetation in the reference area is very uniform, so 20 samples were initially selected then tested for sample adequacy. On site, 40 samples were initially selected.

We visually estimated ground cover within each quadrat to the nearest whole percent cover. Within each quadrat, we determined the percent of the ground covered by each plant species. If two different species of plants overlapped as ground cover, for example grass underneath a shrub, we only recorded the uppermost canopy. The individual plant species were added together for a total vegetative cover. We then estimated litter, standing dead, and rock to the nearest one percent. The remaining percent was calculated as bare ground for a total of 100 percent ground cover.

Although not required for bond release, we also determined shrub density, species diversity, and visually inspected the sites. Each shrub rooted within the ground cover quadrats was counted by species for shrub density. Our visual inspection consisted of surveying the site for general condition and plant growth during the monitoring surveys. During these surveys, we assessed the current state of the site and the plant species present were noted.

2.2 Sample Adequacy

To ensure that a representative average of the ground cover was recorded, an adequate number of samples must be taken. We determined this number using the following formula from Division guidelines:

$$n_{min} = \frac{t^2 s^2}{(dx)^2}$$

where: n_{min} = minimum number of samples necessary, based on total cover or density estimates
x = sample mean
s = standard deviation of the sample
t = the t value for a 1-tailed t-test at 90% confidence (= 1.31)
d = desired change in the mean (= 0.1)

The Division guidelines recommend a minimum of 10 samples per site be measured for both cover and density. They suggest using a 10% change in the mean with a 90% confidence interval. The Division does not recommend a maximum number of samples.

3.0 RESULTS

The results are presented for vegetative plant cover and shrub density for the reclaimed JB King site, and compared to the reference area. Observations during the visual inspection are also presented.

3.1 Plant Cover

We have observed from surveys in 1991 to the present that the number of species at the J.B. King Mine has remained fairly constant over the past several years. A few native species continue to become established on the reclaimed site, and some species are increasing in abundance. Table 3-1 is a floristic list of all plant species recorded on the J.B. King mine site. Nomenclature follows the floristic manual by Welsh, Stanley, et al., 1987. A Utah Flora.

Plant cover results are given in Table 3-2. Total desirable plant cover on the mine site was 18.4% in 1998 and 18.7% in 1999. On the reference area, total plant cover was 13.1% in 1998 and 19.8% in 1999. A greater percent cover and variety of shrub species were present on the mine site as compared to the reference area. However, the reference area was covered by more and a greater variety of forbs.

On the mine site, the woody shrubs were the most abundant vegetation and covered an average of 14% of the ground in 1998 and 17% in 1999. Grasses covered slightly less than 5% and 2% of the ground in 1998 and 1999 respectively. Herbaceous dicots species as forbs were not abundant during our survey and comprised less than 0.1% of the ground cover either year. Litter and standing dead plant material each accounted for about 7% of the cover in 1998 and a total of 7% in 1999. Surface rock and rock mulch comprised an average of about 25% of the ground

cover both years. The remaining 41% and 46% of the ground was bare.

The 3 categories of vegetative cover were more evenly distributed on the reference area. Grasses, shrubs, and forbs comprised 6.3, 4.3, and 2.5% of the ground cover respectively in 1998 and 9.5, 8.6, and 1.8% in 1999. Litter covered 4.5% of the ground in 1998 and 5.7% in 1999. Standing dead plant material covered slightly less than 4% of the ground in 1998 and 1.1% in 1999. Although the rock surface cover was visually prominent, it consisted of numerous very small pebbles. The rock surface averaged less than 6% of the ground cover in the 2 years. The remaining 73% and 68% of the ground surface was bare.

3.2 Shrub Density

Table 3-3 list the average number of viable shrubs and subshrubs rooted within the quadrats by species and the density for each shrub species by hectare and acre for the mine site and reference area.

On the mine site, total shrub density was measured at 2,875 shrubs per acre in 1998 and 4,633 for shrubs (483 subshrubs) in 1999. On the reference area, 8,400 shrubs per acre in 1998 and 4,800 shrubs (20,200 subshrubs) in 1999. A greater variety of shrubs were present on the mine site as compared to the reference area.

On the mine site, four-wing saltbush (*Atriplex canescens*) was the most abundant woody plant species with an average density of 2,433 shrubs per acre. Greasewood (*Sarcobatus vermiculatus*) was the second most abundant species at 1,067 shrubs per acre.

Shadscale (*Atriplex confertifolia*) is the only true shrub on the reference area. We determined a total of 4,800 shrubs per acre for shadscale. Broom snakeweed (*Gutierrezia sarothrae*) and cactus (*Opuntia* sp) were the half or subshrubs on the reference area. Only 3 cactus were counted in the 20 plots for an average of 600 cactus per acre. Snakeweed was very abundant and dominated the non-herbaceous vegetation at 20,200 plants per acre.

3.3 Sample Adequacy

We calculated plant cover sample adequacies for this sampling period as follows;

For the J. B. King site:

$$n_{min} = \frac{1.31^2 \times 17.9^2}{(0.1 \times 18.7)^2} = 175$$

At least 175 samples were need. We had originally done 40 samples with a sample adequacy of 164 samples. When we took 20 more samples, the sample adequacy (with 60 samples total) was higher than with 40 samples. Since the sample adequacy was an increasing target, we stopped at 60 samples. The J.B. King site is a heterogeneous mosaic of differing slopes and aspects resulting in wide differences in percent plant ground cover. The total percent plant cover did not change significantly between 40 samples (18.68%) and 60 samples (18.73%). This cover was also similar to the 1998 monitoring at 18.4%, indicating a stable vegetative cover.

For the reference area:

$$n_{min} = \frac{1.31^2 \times 4.3^2}{(0.1 \times 19.8)^2} = 8$$

At least 8 samples were needed for sample adequacy, 10 to met The Division's requirements. Since we sampled 20 quadrats, no more samples were needed.

4.0 DISCUSSION

Our monitoring survey determined plant cover, shrub density, and an overall visual survey of the J.B. King Mine site over the last two years. Vegetative cover on the site was 18 to 19% and the shrub density was 2,875 to 4,633 shrubs per acre. This compares favorably to the reference area with 13 to 20% cover and 8,400 to 4,800 shrubs per acre.

The average plant cover on the mine site was 21.2%. This plant cover broke down into:

- 79% shrubs
- 9% grasses
- <1% forbs
- 12% weeds

Average desirable plant cover was 18.7%. The reference area had 19.8 % plant cover with a more even distribution between shrubs, grasses, and forbs and no significant weedy plant species. Although the site differs from the reference area in plant composition, the site has

greater plant productivity and overall species diversity as compared to the reference area. This may be due in part to the differences in soil profile age and substrate, a topography, aspect, and elevation between the two sites. Also, the mine site is in a successional stage of vegetation development and protected from livestock grazing. The reference area is a mature plant community and stable for plant cover and density.

Shrub density is slightly higher on the reference area as compared to the mine site, 4,633 and 4,800 shrubs per acre respectively. The shrubs on the mine site as compared to the reference area have:

- wider spaces between the plants
- a more random pattern
- a greater diversity
- larger individual plants

Shrub diversity on the site was 11 species of shrubs and half-shrubs compared to 3 species on the reference area. Shrubs on the reference area were small and uniformly spaced.

The vegetation on the site was impacted by cattle grazing early in the 1999 growing season. The grasses and herbs were targeted by the cattle. The grasses had low productivity and generally failed to flower and set seed. The herbaceous plants were almost non-existent. In contrast to 1998, in 1999 the reference area did not appear to be grazed or was only lightly grazed. Grasses and herbs in the reference area were numerous and generally seeded out.

5.0 CONCLUSION

We recommend that Western States Minerals can apply for Phase II and III bond release based on the vegetative cover on the J.B. King Mine site as compared to the site's reference area. The vegetative cover on the mine site is within 90% of the reference area. We measured cover on the mine site at 18.7%. The reference area had 19.8% vegetative cover. Although not required for bond release, shrub density on the site was approximately 97% of that on the reference area. Vegetation on the mine site is productive and stable and the site provides good animal habitat as compared to the surrounding area.

Table 3-1. Plant Species Floristic List for J.B. King Mine, June 1998.

SHRUBS			
Artemisia arbuscula	low sagebrush	*Ceratoides lanata*	Winterfat
A. bigelovii	bigelow sagebrush	*Chrysothamnus nauseosus*	Rubber rabbitbrush
A. filifolia	sand sagebrush	*C. greenei*	Green rabbitbrush
A. frigida	fringed sagebrush	*Eriogonum corymbosum*	Clustered buckwheat
A. ludoviciana	cudweed sagewort	*Gutierrezia sarothrae*	Broom snakeweed
Atriplex canescens	four-wing saltbush	*Sarcobatus vermiculatus*	Greasewood
A. confertifolia	shadscale	*Tamarix pentandra*	Tamarisk
A. gardneri	Gardner's saltbush	*Yucca harrimaniae*	Harriman yucca
GRASSES			
Agropyron cristatum	crested wheatgrass	*Hilaria jamesii*	Galleta
A. smithii	western wheatgrass	*Hordeum jubatum*	Foxtail barley
A. spicatum	bluebunch wheatgrass	*Oryzopsis hymenoides*	Indian rice grass
A. trichophorum	Intermediate wheatgrass	*Poa fendleriania*	Fendler's bluegrass
Aristida purpurea	purple threeawn	*P. secunda*	Sandberg bluegrass
Bouteloua gracilis	blue grama	*Sitanion hystrix*	Squirreltail
Bromus japonicus	Japanese brome	*Sporobolus cryptandrus*	Sand dropseed
B. tectorum	cheatgrass	*Stipa comata*	Needle-and-thread
FORBS			
Aster chilensis	Pacific aster	*Lappula squarrosa*	European stickseed
A. foliaceous	Leafybract aster	*Lepidium lasiocarpum*	Peppergrass
Astragalus spp	Milkvetch	*Linanthus septentrionalis*	Linanthus
Chenopodium spp	Goosefoot	*Machaeranthera Tanacetifolia*	Tansy-leaf aster
Cleome lutea	yellow beeplant	*Malcomia africana*	African mustard
Descurainia pinnata	tansy mustard	*Melilotus officinalis*	Sweet clover
D. sophia	Flixweed	*Penstemon palmeri*	Beards tongue
Erigeron speciosus	Oregon daisy	*Phacelia heterophylla*	Scorpion weed
Eriogonum spp	Buckwheat	*Plantago patagonica*	Patagonia plantain
Haplopappus clematis	clement goldenweed	*Polygonum aviculare*	Knotweed
H. spp	Goldenweed	*Sphaeralcea Grossulariaefolia*	Gooseberry-leaved globemallow
Helianthus annuus	Common sunflower	*Tragopogon dubius*	Oyster-plant
Heterotheca villosa	hairy golden aster		
CACTUS			
Opuntia polyacantha	Beavertail	*Sclerocactus whipplei*	Fishhook
WEEDS			
Halogeton glomeratus	Halogeton	*Salsola kali*	Russian thistle
Kochia americana	Summer cypress		

Table 3-2. Average Percent Plant Cover at the J.B. King site, June 1998 and July 1999

Ground Cover Type	Plant Species	Mine Site (% cover)		Reference Area (% cover)	
		1998	1999	1998	1999
Shrubs	Artemisia nova	0.1			
	Artemisia tridentata		0.3		
	Atriplex canescens	10.5	11.0		
	Atriplex confertifolia	0.7	0.8	3.4	3.8
	Atriplex gardneri	0.8	0.1		
	Ceratoides lanata	0.3	0.2		
	Chrysothamnus greenei	0.1			
	C. nauseosus	0.1	0.1		
	Gutierrezia sarothrae	0.3	0.2	0.8	4.7
	Opuntia polyacantha			0.1	0.1
	Sarcobatus vermiculatus	1.0	4.1		
	Total	13.9	16.8	4.3	8.6
Grasses	Agropyron trichophorum	2.4	0.1		
	Agropyron sp.	0.2	1.2		
	Bouteloua gracilis	trace	trace		1.1
	Buchloe dactyloides			1.6	
	Hilaria jamesii	0.2	0.2	2.1	3.6
	Hordeum jubatum			1.5	1.1
	Oryzopsis hymenoides	0.9	0.2	0.3	0.5
	Sitanion hystrix	0.2	0.1		1.1
	Sporobolus cryptandrus	0.4	trace	0.8	1.9
	Stipa comata	0.1	0.1		0.1
	Total	4.4	1.9	6.3	9.4
Forbs	Cryptantha sp.			0.1	
	Haplopappus clematis	trace			0.1
	Langlosia sp.			trace	
	Lappula squarrosa	0.1		0.2	
	Plantago sp.			0.2	
	Phacelia sp.			0.1	
	Sphaeralcea coccinea	trace		1.6	1.2
	Townsendia sp.			0.2	0.5
	Total	0.1	0.0	2.5	1.8
Desirable Plant		18.4	18.7	13.1	19.8
Weeds		1.2	2.4	0.0	0.0
Standing Dead		7.3	1.3	3.8	1.1
Litter		7.6	5.4	4.6	5.6
Rock		24.2	26.3	5.6	5.2
Bare ground		41.3	45.9	72.9	68.3

Table 3-3.Shrub Density for the J.B. King site, July 1999

Species	Shrubs per 4 sq meters	Shrubs per hectare	Shrubs per acre
Mine Site			
Shrubs			
Atriplex canescens	2.43	6,083	2,433
Sarcobatus vermiculatus	1.07	2,667	1,067
Ceratoides lanata	0.40	1,000	400
Atriplex confertifolia	0.40	1,000	400
Atriplex gardneri (castle valley)	0.10	250	100
Atriplex gardneri	0.08	208	83
Artemisia tridentata	0.08	208	83
Chrysothamnus nauseosus	0.07	167	67
total	4.63	11,583	4,633
Subshrubs			
Gutierrezia sarothrae	0.38	958	383
Sphaeralcea coccinea	0.10	250	100
total	0.48	1,208	483
Total for Site	5.12	12,792	5,117
Reference Area			
Shrubs			
Atriplex confertifolia	1.20	12,000	4,800
total	1.20	12,000	4,800
Subshrubs			
Gutierrezia sarothrae	4.90	49,000	19,600
Opuntia sp.	0.15	1,500	600
total	5.05	50,500	20,200
Total for Reference Area	6.25	62,500	25,000

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